processing of the back-facing shadow polygons includes obtaining the depth value of each pixel of the back-facing shadow polygons, comparing the depth value with a corresponding Z value obtained from the Z-buffer memory, and if the depth value is equal to or greater than the corresponding Z value, then the pixel is processed as the back-facing shadow polygon, and

processing of the front-facing shadow polygons includes obtaining the depth value of each pixel of the front-facing shadow polygons, comparing the depth value with a corresponding Z value obtained from the Z-buffer memory, and if the depth value is smaller than the corresponding Z value, then the pixel is processed as the front-facing shadow polygon,

such that the pixels are identified and provided with color representing the shadow if the pixels are associated with a front-facing shadow polygon in front of one of the normal polygons, and a back-facing shadow polygon in back of another of the normal polygons.

However, the Bilodeau reference, whether taken alone or in combination with Shimizu, does not teach or suggest a graphic processing apparatus or method including at least the above limitations, as recited in independent claims 1, 4, and 9.

In Bilodeau, a front facing shadow polygon 16 is rendered first by conducting a z-test for each pixel and only if the z-value of the front facing pixel passes the standard test, i.e., the front facing shadow polygon 16 is in front of the normal polygon, such as first and second scene polygons 20 and 22, then the stencil buffer entry for the pixel is incremented (+1). In Bilodeau, the back facing shadow polygon 14 is rendered secondly by conducting a z-test for each pixel and only if the z-value of the back facing pixel passes the standard test, i.e., the back facing shadow polygon 14 is in front of the normal polygon such as the first scene polygon 20, then the stencil buffer entry for the pixel is decremented (-1) (see, e.g.,

column 2, lines 41-48 of Bilodeau). This rendering process and its result are explained referring to FIG. 2 of Bilodeau (see, e.g., column 2, line 49 to column 3, line 2 of Bilodeau).

In other words, the method for rendering a shadow polygon in Bilodeau is the same as in the "OpenGL" reference, as described in paragraphs 0011-0015 of the Background section of the original specification.

In particular, as described in paragraphs 0013-0014 of the original specification, it is stated (emphasis added):

> More particularly, with regard to front-facing shadow polygons facing front when seen from a visual point, a "depth test" is carried out for determining whether or not depth values of the polygons are smaller than Z values in the Z-buffer memory, and as shown in FIG. 13F, a numeral "1" is written in a region of the front-facing shadow polygons where the result of the depth test is "true" in the stencil buffer. ...
>
> More particularly, with regard to back-facing shadow polygons facing back when seen from a visual point, the aforementioned depth test is carried out, and a numeral "-1" is added to a region of the back-facing shadow polygons where the result of the depth test is "true" in the stencil buffer.

In other words, as described in paragraphs 0013-0014 of the original specification, according to the "OpenGL" reference which corresponds to Bilodeau, *the front facing shadow polygon is in front of the normal polygon*, and *the back facing shadow polygon is in front of the normal polygon*. As a result, Bilodeau is subject to the same problems as described in paragraphs 0017-0018 of the original specification. In particular, if calculation values of coordinate conversion for polygons have errors, then an edge portion of the shadow polygons which is originally not intended to be shadowed is also shadowed.

In detail, Bilodeau's method also has such calculation errors, so that a side RS of the front-facing shadow polygon RS(T)U is shifted from a line RS of the back-facing shadow polygon RSVW to a left back side viewed from a visual point as shown in PRIOR ART FIG. 14 of the application. In this case, a lateral portion R'S'SR of the front-facing shadow polygon R'S'T'U' is positioned outside of the back-facing shadow polygon RSVW. As a result, front surface data "1" written in a region R'S'SR in the stencil buffer remains without being erased by back surface data "-1", which places a shadow on the region R'S'SR on the lateral side of the front-facing shadow polygon R'S'T'U', which is not intended to be shadowed.

In contrast to Bilodeau's method, the graphic processing apparatus as recited in independent claim 1 (see also independent claims 4 and 9) provides color and processes the back-facing shadow polygon in a different manner than that described in Bilodeau. In particular, as recited in independent claim 1, the depth value of each pixel of the front-facing shadow polygon is compared with a corresponding Z value obtained from the Z-buffer memory, and if the depth value is smaller than the corresponding Z value, *i.e., the front facing shadow polygon is in front of the normal polygon,* then the pixel is processed (i.e., judged) as the front-facing shadow polygon. While, as recited in independent claim 1, the depth value of each pixel of the back-facing shadow polygon is compared with the depth value of a corresponding Z value obtained from the Z-buffer memory, and if the depth value is equal to or greater than the corresponding Z value, *i.e., the back facing shadow polygon is at the back of the normal polygon,* then the pixel is processed as the back-facing shadow polygon. Finally, as recited in the last paragraph of independent claim 1, the pixels are identified and provided with color representing the shadow if the pixels are associated with a front-facing shadow polygon of one of the normal polygons, and back-facing shadow polygon in back of another of the normal polygons, *i.e., normal polygons that located between front-facing shadow polygon and back-facing shadow polygon are provided with shadow color, as pixels on the two dimensional screen.*

Therefore, as shown in FIG. 14 of the application, even if side RS of the front-facing shadow polygon RS(T)U is shifted from a line RS of the back-facing shadow polygon RSVW to a left back side due to calculating error in coordinate conversion for polygons, the lateral portion RR'S'S is positioned at the back of the front-facing shadow polygon R'S'T'U' but is positioned outside of *(i.e., not positioned in front of)* the back-facing shadow polygon RSVW and thus the lateral portion RR'S'S is not provided with shadow color. In other words, a coordinate region that is positioned behind the front-facing shadow polygons and in front of the back-facing shadow polygons viewed from the visual point is shadowed, so that even if conversion calculation values of the graphic data on the normal polygons and the shadow polygons have errors, an edge portion of the shadow polygons which is not intended to be shadowed is not shadowed (see, e.g., paragraphs 0044 and 0093 of the original specification).

The same effect is performed as described in paragraphs 0094-0095 of the original specification, referring to FIG. 11. As shown in FIG. 11, even if a polygon "abci" (see FIG. 9) on the back side of the globe 22 viewed from the light source 21 and a front-facing shadow polygon "abcgfe" (see FIG. 9) viewed from a visual point are shifted from a polygon "abcu" (see FIG. 11) on the front side of the globe 22 viewed from the light source 21 and a back-facing shadow polygon "adcghe" viewed from the visual point toward the left-hand side in the figure, shadows are placed on a region "al.'rgb" and a region "sl'tj" in front of the back-facing shadow polygons and behind the front-facing shadow polygons viewed form the visual point. Therefore, an edge portion "qcTtir" of the shadow polygon is not provided with a shadow.

In contrast to this, if misalignment of polygons as shown in FIG. 11 occurs when using Bilodeau's method, which corresponds to the "OpenGL" reference, a shadow is also placed on a lateral portion "qcTtjr" of a front-facing shadow polygon "a'b'c'fl"'. As described in paragraph 0096 of the original specification, in the field of game machines, downsizing, lower power consumption and simplification (lower price) of the system are required for

application of the system to portable devices, and in such a condition, graphics processing should still be performed at visually appropriate level. According to the claimed apparatus and method, even if errors are generated during conversion of graphic data, visual noise is not generated, which makes it possible to perform visually appropriate graphics processing with a simplified constitution.

For at least the reasons discussed above, the Bilodeau reference, whether taken alone or in combination with Shimizu, does not teach or suggest a graphic processing apparatus or method including at least the above limitations, as recited in independent claims 1, 4, and 9. Therefore, independent claims 1, 4, and 9 and their respective dependent claims are patentable over Bilodeau (or Shimizu in view of Bilodeau).

It is believed the application is in condition for immediate allowance, which action is earnestly solicited.

Respectfully submitted,

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